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GAS ABSTRACTS

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1. GAS INDUSTRY

Canadian Gas

Brownie, F. A. SEES BRIGHT FUTURE FOR NATURAL GAS IN WESTERN CANADA. *Can. Gas J.*, 48, 9, 10, 40 (1955) October.

Excerpts from an address by the president of Canadian Western Natural Gas Company and Northwestern Utilities Ltd. before the Independent Natural Gas Association of America.

R. F. Bukacek

Future of Fuels

Batchelder, H. R. and Nelson, H. W. FUTURE OF SYNTHETIC LIQUID AND GASEOUS FUELS. *Combustion*, 27, 49-53 (1955) November; *Mech. Eng.*, 78, 11-14 (1956) January.

Toward the end of World War II interest in the development of a synthetic-fuels industry to meet a tremendous increase in the demand for petroleum products became keen. Technically the problems are surmountable but economically conditions do not favor such production. This paper examines the factors that will determine the production of synthetics almost without regard to present price structure. Data on energy reserves, production and demand are analyzed, with projections, given for the year 1975, based on several population growth estimates. For 1975, projections indicate a total demand for petroleum of 14.6 million bbl. per day (5.3 billion per year) and an annual marketed production of natural gas of 17.3 trillion CF. To meet such demands, commercial scale synthesis should be in operation for liquid fuels before 1970, and for gas before 1975.

Authors' Abstract

Nickerson, A. L. MEETING FUTURE U. S. OIL NEEDS TO BE A TOUGH JOB. *World Oil*, 141, 64-67 (1955) November.

U. S. producers may find it increasingly difficult to meet the growing demand. We're not "running out of oil," but it's getting harder to build reserves. This is true not only because oil is getting harder to find, but because the need for it is increasing so rapidly. Oil use in the Free World outside U. S. is increasing even more sharply, and will equal demand in U. S. in 10 years. Crude output in Free World outside U. S. has caught up with U. S. production this year.

Author's Abstract

Production Control

Kerr, R. S. OIL AND POLITICS *MUST* MIX. *World Oil*, 141, 72-73 (1955) November.

The author says that in the very near future, politics and politicians will determine to a large extent the survival and progress of the oil industry.

Author's Abstract

Irelan, S. B. CAN'T STAND COMPETITION. *Petroleum Eng.*, 27, E4, 6, 8 (1955) November.

The author contends the real danger to our free enterprise system comes from Chambers of Commerce, trade associations and business men who can't stand competition.

R. T. Ellington

GAS CONTROL MEANS FULL CONTROL. *Oil Gas J.*, 54, 130-31 (1955) October 10.

A summary of the opinions expressed by speakers at the 36th Annual Meeting of the Texas Mid-Continent Oil and Gas Association.

R. F. Bukacek

2. APPLIANCES

Air Conditioning

Collins, J. H. "AIR CONDITIONING" IS BIGGER THAN WE THINK. *Public Utilities Fortn.*, 56, 638-55 (1955) October 13.

A challenging review of the progress the gas industry has made in the field of air conditioning load and what the natural gas companies must do to meet the threat of electric competition.

R. S. Walters

NEW 3-TON AIR CONDITIONER ADVANCED TO FIELD TESTING. *Amer. Gas J.*, 182, 51-52 (1955) October.

Experimental models of the new Servel 3-ton all year gas air conditioner, XFC-96-G, are being placed with utilities for field tests. The lithium bromide-water cycle is employed. A single coil in the air stream serves for summer cooling and winter heating, the latter with low pressure steam from the generator. Floor space requirements, freight, assembly time and cost are said to be reduced from earlier models. A general description and some operating data are given. (See also *Gas Abs.*, 11, 209)

J. F. Reed

Controls and Ignition

Mueller, E. H. VALVE FOR CONTROLLING GAS. U. S. 2,723,102 (1955) November 8.

Bishofberger, C. J. (assigned to Minneapolis-Honeywell Regulator Company) SAFETY BURNER CONTROL APPARATUS. U. S. 2,720,255 (1955) October 11.

Ward, C. D. (assigned to Minneapolis-Honeywell Regulator Company) SAFETY BURNER CONTROL APPARATUS. U. S. 2,720,254 (1955) October 11.

Winet, H. (assigned to Landis and Gyr, A.-G.) GAS OVEN TEMPERATURE REGULATOR. U. S. 2,726,041 (1955) December 6.

Electrical Load

Gray, R. COOLING SPURS ELECTRIC HEAT. *Fueloil and Oil Heat*, **14**, 58-61, 162 (1955) October.

An example of the way a rapidly increasing air-conditioning load has spurred efforts by an electric utility to develop a heating load to fill in the winter valleys in load demand.

G. G. Wilson

Range Improvements

NEWEST L.P. GAS RANGE IMPROVEMENT GIVE DEALERS HIGHLY SALABLE PRODUCT, *Butane-Propane News*, **17**, 72, 74, 76, 78, 80 (1955) November.

The features contributing to increased saleability of current models of ranges are summarized. R. T. Ellington

TEM-TROL TOP BURNER UNVEILED. *Gas Age*, **116**, 21, 60 (1955) November 3.

First showing of Roper ranges featuring the fully automatic top burners, under sponsorship of The Gas Service Co. was viewed by 300 visitors. Editor's Abstract

Servicing Liability

Lea, W. L., Jr. THE LEGAL RESPONSIBILITIES OF THE SERVICEMAN WHILE ON CUSTOMER'S PREMISES. *Southern Gas Assoc. Progress*, **25**, 3-5, 10-11 (1955) Fall.

The three links in the chain leading to legal liability are discussed. It is pointed out that the decision in a liability case is made by outsiders in a jury or court and the importance of careful competent work by the gas serviceman is discussed at length. G. G. Wilson

Space Heating

Hauck, R. C., and Nathan, A. L. (assigned to Delta Heating Corp.) FORCED AIR RECIRCULATION FLOOR FURNACE. U. S. 2,725,051 (1955) November 29.

3. COMBUSTION AND INDUSTRIAL FURNACES

Flame Reactions

Batten, J. J. and Ridge, M. J. ON THE LOW-TEMPERATURE OXIDATION OF isoBUTANE AND PROPYLENE. *Australian J. Chem.*, **8**, 370-77 (1955) August.

The effect of additives on the oxidation of isobutane at 290° C. was studied. Formaldehyde and formic acid inhibited the isobutane-oxygen reaction whereas these compounds accelerate the propylene-oxygen reaction. Acetaldehyde accelerates both systems. That a build-up in peroxide content is not necessary for the termination of the induction period was shown by no decrease in reaction rate when the peroxides were destroyed by contact with mercury.

S. A. Weil

Cohen, L. BURNING VELOCITIES OF HYDROGEN SULPHIDE IN AIR AND IN OXYGEN. *Fuel* (British), **34**, S119-122 (1955) April.

The burning velocities of hydrogen sulphide in air and in oxygen have been measured by using a nozzle burner and direct photography of the flame cone. The maximum burning velocity in oxygen, v_b + 550 cm/sec. was observed just inside the oxygen excess region. The results for the mixtures of hydrogen sulphide and air are compared with earlier measurements.

Author's Abstract

Cohen, L. BURNING VELOCITIES OF AMMONIA IN AIR AND IN OXYGEN. *Fuel* (British), **34**, S123-127 (1955) April.

The burning velocities of mixtures of ammonia and oxygen have been measured by using a nozzle burner and direct photography of the flame. The conditions under which a stable flame of mixtures of ammonia and air can be

formed have been investigated and the burning velocities measured by three different methods.
Author's Abstract

Friedman, R. and Cyphers, J. A. FLAME STRUCTURE STUDIES. III. GAS SAMPLING IN A LOW-PRESSURE PROPANE-AIR FLAME. *J. Chem. Physics*, 23, 1875-80 (1955) October.

A water-cooled probe was developed for the sampling of the product gases of a flat flame. The burned products of a very lean propane flame at low pressure were examined for CO in the region 0-4 cm from the luminous zone. As much as 2.5 mole percent CO was found on the downstream side of the reaction zone. The concentration of CO followed an exponential decay law in the distance. The ratio CO/H_2 was 5 as compared to the equilibrium value of 2. No hydrocarbons were detected. The results are indicative of a two-stage mechanism, a rapid oxidation of the fuel to CO and relatively slow step of oxidation of CO to CO_2. S. A. Weil

Kurz, P. F. BEHAVIOUR OF SHIELDED RICH-LIMIT ETHYLENE FLAMES. *Fuel* (British), 34, S54-58 (1955) April.

It has been found that the rich blow-off limits of shielded ethylene flames are markedly extended by comparatively narrow shielding tubes. Under the same physical burner conditions, the stability limits of rich flames of other, slower burning hydrocarbons are essentially unaltered. The primary flame cones of shielded ethylene flames have non-separable yellow mantles at low burner-jet velocities, and they will burn stably at rich fuel-air compositions where the flames of other hydrocarbons, which burn more slowly than ethylene, are unstable. The unique behaviour of ethylene is believed to be associated with the sensitivity of the cracking reactions, which produce the yellow mantle and soot, to external thermal influences.
Author's Abstract

Lee, D. H., Martin, D. G. and Moore, N. P. COMBUSTION WITHIN HEATED TUBES. *Fuel* (British), 34, S107-118 (1955) April.

Studies have been made of the stability of premixed propane-air flames in a ducted burner. Several distinct modes of flame stability have been demonstrated and experiments are described to reveal the different mechanisms of stability. It has been found that stability is in general controlled by the flow pattern at the inlet or by the duct wall temperature, particularly if this temperature is above approximately 900° C.
Authors' Abstract

Simmons, R. F. and Wolfhard, H. G. THE INFLUENCE OF METHYL BROMIDE ON FLAMES. PART I—PRE-MIXED FLAMES. *Faraday Soc. Trans.* (British), 51, 1211-17 (1955) September.

The effect of methyl bromide and of bromine on flammability limits and burning velocity was investigated. The effects of the two additives appear to be similar if the methyl bromides considered in terms of an equivalent amount of bromine and fuel. The additives inhibit the combustion process both in decreasing burning velocity and in narrowing the flammability range. The latter is attributed to an increase in the limit temperature since the additives only slightly affect the theoretical temperatures.
S. A. Weil

Thorp, N., Long, R. and Garner, F. H. CARBON FORMATION IN HYDROCARBON DIFFUSION FLAMES. *Fuel* (British), 34, S1-13 (1955) April.

A study has been made of the carbonaceous residues from diffusion flames of aromatic, naphthenic and paraffinic fuels. Fractions have been obtained from these by processes of solvent extraction and chromatography, and their infra-red and ultraviolet absorption spectra recorded. Many of the fractions insolated from these different types of fuel have similar infra-red spectra. They possess three interesting absorption bands at 1700, 1620 and 1570 cm^{-1}; the first of these, arising from the conjugation of a C=O group, reveals the presence of oxygen within the molecule. Other fractions have similar ultraviolet absorption spectra which do not in general resemble those of polycyclic aromatic compounds, whilst some fractions appear to be long chain olefins. A reaction scheme is tentatively advanced to explain the observations recorded.
Authors' Abstract

Weinberg, F. J. LOCATION OF THE 'SCHLIEREN IMAGE' IN A FLAME. *Fuel* (British), **34**, S84-88 (1955) April.

The position at which maximum deflection of an incident ray of light occurs is calculated. It is concluded that this is situated at a temperature equal to twice the absolute initial temperature in a system of constant thermal conductivity and at one and a half times the initial temperature in air. Author's Abstract

Flue Capacity

Thulman, R. K. CAPACITY OF FLUES. *Fuel-oil and Oil Heat*, **14**, 65-7, 156 (1955) October.

Factors involved in sizing a flue are discussed and a nomograph is presented from which the carrying capacity of any 6- or 7-inch flue can be found for any height between 2 and 22 feet. G. G. Wilson

Fume Heat Recovery

Ruff, R. J. SAVING FUEL WITH CATALYTIC HEAT RECOVERY, *Ind. Gas*, **34**, 6-9 (1955) October.

Recently the application of low-temperature catalytic combustion of vapors has emphasized heat recovery at least as much as odor destruction. A number of types of heat recovery installations are discussed. R. T. Ellington

Ignition

Dolan, J. E. and Dempster, P. B. THE SUPPRESSION OF METHANE-AIR IGNITIONS BY FINE POWDERS. *J. Appl. Chem.* (British), **5**, 510-17 (1955) September.

The effect of the particle size of some inorganic materials on their efficiency as ignition suppressors has been studied. It has been found that there is a direct relationship between this efficiency and the surface area of the powder exposed to the advancing flame. Flame inhibitors have been placed in an order of efficiency on this basis. The alkali halides have been shown to have an efficiency which cannot be fully accounted for by the thermal characteristics of the powders, and an explanation is suggested. Authors' Abstract

Industrial Gas Distribution

Webber, J. E. DISTRIBUTION CONTROL OF MIXED GAS. *Instr. and Autom.*, **28**, 1528-31 (1955) September.

Control of extensive steel-mill mixed-gas system involved inter-related control of pressures, flows, heat flow factor, booster speed, and holder position. The basic problems, initial systems, required revisions, and results are discussed. Heat-flow-factor control proved important. Author's Abstract

Industrial Heating

Brinkerhoff, J. E. INSULATING FIRE BRICK CAN CUT PRODUCTION AND FUEL COSTS. *Ind. Heating*, **22**, 2123-32 (1955) October.

The advantages of light-weight insulating brick in cutting heating-up time and heat loss are presented. R. T. Ellington

Furczyk, A. A. FIRST CONTINUOUS ALUMINUM MELTING FURNACE. *Ind. Gas*, **34**, 10-11, 21-22 (1955) October.

The application of automatic control, rapid melting with radiant heat, and minimum holding of liquid metal to aluminum melting is described. Fuel economy and improved working conditions are stressed. R. T. Ellington

Mawhinney, M. H. HEAT TRANSFER IN INDUSTRIAL HEATING FURNACES: I. *Ind. Heating*, **22**, 2011-19, 2038 (1955) October.

A general discussion is given of the modes of heat transfer along with rough values of transfer coefficients for various conditions. R. T. Ellington

Mehrkam, Q. D. NEW ADVANCEMENTS IN HOT SALT QUENCHING. *Ind. Heating*, **22**, 1980-90, 2210-13 (1955) October.

A detailed description is given of the uses of molten salt baths for quenching in austempering and martempering. R. T. Ellington

Rappolt, H. G. METAL FINISH BAKING WITH GAS RADIANT AND CONVECTION. International Gas Union Paper IGU/18-55, 6th Conference, New York 1955, September 26-30.

1) Paint on metal can be properly baked only if the metal as well as the paint is heated to the proper temperature conditions. 2) Paint baked with the same time-temperature curve with either radiant or convected heat will have the same properties of finish. 3) High heat

potentials, with radiation or convection, shorten the heating-up time but introduce problems of non-uniformity in the finished product. 4) High-temperature gas radiant burners have the highest concentration and temperature, but their potential rate of heat-up is so fast that control may be lost, except on special applications. 5) Low-temperature radiant panels are a little more restrained but still have a high rate of heat-up with flat painted metal. 6) Forced convection ovens, depending on design, can be such as to have a low rate of heat-up, or can be comparable to most radiant heat systems. They can hold the work to close temperature control, and are best suited to finishes requiring definite limits of time-temperature, and to work of various surfaces, shapes, thickness and color.

Author's Abstract

Nuclear Power

Simpson, J. W. and Show, M. THE U. S. A. PRESSURIZED WATER REACTOR POWER PLANT. *Chem. Eng. Progress*, **51**, 437-40 (1955) October.

A general description of the nuclear power reactor is given. Details are covered on size, control systems, construction materials and auxiliaries such as waste disposal.

W. G. Bair

Protective Atmospheres

Funk, E. J. GAS AS A SOURCE OF PROTECTIVE ATMOSPHERE IN INDUSTRIAL FURNACES. *Ind. Heating*, 22, 2030-38 (1955) October.

Endothermic and exothermic atmosphere gases are reviewed and equilibrium composition curves are given for coke-oven and natural gas feed.

R. T. Ellington

Smog Research

Bowerman, F. R. (Editor) SUMMARY OF THE CONFERENCE ON INCINERATION, RUBBISH DISPOSAL AND AIR POLLUTION. Air Pollution Foundation, 1, No. 3, pp. 1-52, Los Angeles (1955) January.

Conference members bring out in 20 papers that no contemporary domestic incinerator operates without objectionable smoke, odor, and fly ash as regards air pollution. It is brought out that fundamental research is required into the fundamental variables of incinerator operation to determine the causes of malfunction.

R. T. Ellington

Faith, W. L., Hitchcock, L. B., Neiburger, M., Renzetti, N. A., Rogers, L. H. FIRST TECHNICAL PROGRESS REPORT COVERING WORK DONE IN 1954. Air Pollution Foundation, 1, No. 4, pp. 1-89, Los Angeles (1955) March.

This report covers meterological and chemical aspects of smog, combustion products and aerometric surveys. It reiterates the inadequacy of present domestic incinerators as regards ultimate smog prevention requirements.

R. T. Ellington

Turbine Auxiliary

Shapiro, A. M., Wadleigh, K. R., Gavril, B. D., and Fowle, A. A. THE AEROTHERMOPRESSOR — A DEVICE FOR IMPROVING THE PERFORMANCE OF A GAS-TURBINE POWER PLANT. Amer. Soc. Mech. Eng. Paper No. 55—SA-65. Boston (1955) June.

This paper presents an introduction and a progress report on a novel aerothermodynamic device which performs the function of a compressor. The aerothermopressor is a duct within which atomized water evaporates into a high-speed stream of high-temperature gas, thereby inducing a rise in isentropic stagnation pressure of the gas stream. One of the most attractive applications of this type equipment is as an auxiliary for improving the performance of a gas turbine plant.

R. F. Bukacek

4. CARBONIZATION AND GASIFICATION

Ammonia Recovery

Moquard, M. P. OBTENTION D'EAUX AMMONIACALES CONCENTREES DANS LE LAVAGE MEME DU GAZ. (PRODUCTION OF CONCENTRATED AQUA AMMONIA BY THE DIRECT WASHING OF GAS.) *J. Usines Gaz* (French), **79**, 394-404 (1955) October.

Results of a plant-scale test of several weeks are reported with detailed data, indicating that recovery of ammonia by direct washing was economic (over 40 gpl.) when proper control of gas temperatures was obtained at the outlet of the primary condenser. Chilled condenser water, low CO_2 (2.8%) content of gas, and recirculation of flushing liquor from the decanters were carefully adjusted to attain a high concentration of NH_3 in the gas (3.9 g/m^3) at the washer.

O. P. Brysch

Coal Hydrogenolysis

Pelipetz, M. G., Salmon, H. R., Bayer, J., and Clark, E. L. UNCATALYZED COAL HYDROGENOLYSIS. *Ind. Eng. Chem.*, 47, 2101-03 (1955) October.

This is a companion study to previous work in the presence of tin and molybdenum under initial hydrogen pressures of 500 to 4000 psi and 400° C. The rate of transformation of benzene-insoluble matter of coal to oil and gas was used as a measure of catalyst activity. Gaseous hydrocarbon production was significantly higher without catalyst, ranging from 4 to 10 weight percent. Reaction rate constants were found to vary linearly with pressure. Equal reaction rates were found with 1 percent molybdenum at 500 psi initial pressure, and without catalyst at 10,000 psi.

E. B. Shultz

Gasification of Carbon

Ergun, S. FLOW EXPERIMENTS IN STUDYING KINETICS. *Ind. Eng. Chem.*, 47, 2075-80 (1955) October.

Results are presented of some of the experimental work in which the effect of diffusion, inert gases, gas mixing and flow pattern on gasification reaction rates was investigated. They are based on the gasification of carbon with carbon dioxide and steam at temperatures in the range of 700° to 1400° C.

E. J. Pyrcioch

Tuddemham, W. M. and Hill, G. R. CATALYTIC EFFECTS OF COBALT, IRON, NICKEL, AND VANADIUM OXIDES ON STEAM-CARBON REACTION. *Ind. Eng. Chem.*, 47, 2129-33 (1955) October.

The results of this study show that the treatment of carbon samples with very small quantities of cobalt, iron, nickel and vanadium oxide catalysts is effective in producing a considerable increase in the carbon reactivity and gasification rate in steam carbon reaction at temperature of 1050 to 1100° C. E. J. Pyrcioch

Hydrocarbon Gasification

Massimilla, L. SULLA CONVERSIONE CON VAPORE D' ACQUA, A TEMPERATURA ELEVATA, DEGLI IDROCARBURI PRESENTI NEI GAS DI DISCARICA DELLE RAFFINERIE DI PETROLIO. (CONVERSION BY STEAM AT ELEVATED-TEMPERATURES OF THE HYDROCARBONS IN PETROLEUM REFINERY GAS. *Rivista dei Combustibili* (Italian), 9, 759-88 (.955) *October.*

The authors report on the conversion of refinery gas into a gas interchangeable with ordinary town gas. They particularly turned their attention to the conversion of hydrocarbons up to C4 by steam, at varying temperatures on piles of silico-aluminous refractory material or coke-beds. Preliminary investigations in conjunction with thermodynamic considerations enable the behavior of these complex transformations to be foreseen; their accomplishment being notably influenced by kinetic factors which are in turn connected with the temperature and the presence of the above-mentioned solids. Trials have been made on an industrial scale with a gas producer generating 60,000 m^3/day of integral gas. Author's Abstract

Stewart, S. G. (assigned to Phillips Petroleum Co.) SYNTHESIS GAS MANUFACTURE. U. S. 2,719,130 (1955) September 27.

This is a process for the manufacture of synthesis gas by the partial oxidation of a hydrocarbon material, wherein oxygen therefor is produced by a novel inexpensive method, thus eliminating the need for expensive air-fractionation equipment, and reducing the oxygen cost requirements to a small fraction of those proposed heretofore. A carrier gas is passed through a body of metallic oxide at a temperature at which free oxygen is liberated. Such a carrier gas may be a hydrocarbon gas, steam or carbon dioxide that may form synthesis gas. Tail gas from a Fischer-Tropsch synthesis step may serve. The resulting carrier gas-oxygen mixture is modified, as desired, passed to the partial oxidation zone and therein converted to synthesis gas. The oxide body can be utilized in fluid bed, fixed bed or moving bed type operation. Metallic oxides used herein are those which liberate oxygen at temperatures below those at which change in the carrier gas occurs, and which are regenerated by the action of an oxygen-containing gas, such as air. Among the preferred oxides are mercury oxides, lead oxides, and silver oxides. Other oxides that can be used include strontium oxide, SrO_2; tin oxide, SnO_2; cobalt oxide, Co_2O_3, and barium peroxide, BaO_2. Inventor's Abstract

HCN Recovery

Gollmar, H. A. (assigned to Koppers Co., Inc.) PROCESS AND APPARATUS FOR PRODUCTION OF HYDROGEN CYANIDE. U. S. 2,719,595 (1955) October 4.

In absorption-desorption processes for recovery of CN from HCN-bearing gases such as coke-oven gases, deposition of black solid material apparently formed by polymerization of material in the gas at certain zones of the absorber and rectifier is prevented by sweeping these zones with a flow of steam. D. M. Mason

Hydrogen Generator

Gill, G. C. HYDROGEN GENERATOR. U. S. 2,721,789 (1955) October 25.

A low-pressure hydrogen field generator is claimed in which water is reacted with a weighed charge of mixed aluminum granules and flake sodium hydroxide. The charge reacts in a conical bottom zone, the hydrogen rises and its water content is condensed by tubular exchanger the vertical tubes of which are water-cooled. The hydrogen may be drawn off from a chamber above the top header plate, or may be warmed by return flow through pipes in the tube-nest before withdrawal. O. P. Brysch

Methane Sorption

Moffat, D. H. and Weale, K. E. SORPTION BY COAL OF METHANE AT HIGH PRESSURES. *Fuel* (British), 34, 449-62 (1955) October.

The adsorption of methane by a number of British coals at 25° C. and up to 1000 atm pressure has been studied in relation to the release of methane from coal seams. A sorption mechanism was developed from experimental isotherms and coal expansion measurements, and the effects of coal structure is discussed.

E. B. Shultz

Oil Gas

Pettyjohn, E. S. and Linden, H. R. (assigned to The Institute of Gas Technology, Chicago, Ill.) THERMAL METHOD OF MAKING OIL GAS. U. S. 2,721,122 (1955) October 18.

Oil gas completely interchangeable with natural gas is made by cracking a petroleum fraction of straight-run naphtha grade or heavier at a pressure of 2 to 4 atmos, temperatures of 1300° to 1750° F., residence times of 2 to 15 seconds and removing the light aromatics from the product gas. A cyclic regenerative, four-checker cracking process is claimed in which oil is cracked in No. 3 and No. 4 checkers, oil gas is collected, then air blown through Nos. 4, 3, 2, 1, in sequence while oil is burned in 2 with additional air in 2 and 1; then oil is cracked in 2 and 1, oil gas is collected, then air blown through 1, 2, 3, 4 while heating oil is burned in 3 and 4 with air; then repeating the cycle.

O. P. Brysch

Pettyjohn, E. S. and Linden, H. R. (assigned to The Institute of Gas Technology, Chicago, Ill.) METHOD OF MAKING OIL GAS INTERCHANGEABLE WITH NATURAL GAS. U. S. 2,721,123 (1955) October 18.

Oil gas is made by thermally cracking a gas containing 50 to 75 per cent gaseous hydrocarbons, (natural gas or oil gas), passing hot cracked products into a reactor, while simultaneously introducing into this reactor a normally liquid petroleum fraction to be cracked at 1350 to 1750° F. in the presence of the cracked gaseous products without steam. Such product gas is more completely interchangeable with natural gas than conventional high-Btu oil gas, and can be made more so by operating at superatmospheric pressure, or with autohydrogenation by passing the gas over a hydrogenation catalyst. O. P. Brysch

Reformed Gas

Haug, J. S. (assigned to The United Gas Improvement Co.) PROCESS AND APPARATUS FOR MANUFACTURING GAS RICH IN HYDROGEN. U. S. 2,720,450 (1955) October 11.

A cyclic process is claimed for manufacture of hydrogen-rich gas, in which first fuel is burned in a combustion chamber and the hot combustion gases divided to heat in parallel two heat-storage and catalyst zones. Each zone comprises a first refractory storage, a reforming catalyst (nickel) zone and a second refractory storage zone. On the "make" cycle, gaseous hydrocarbon and steam are passed consecutively through both storage-catalyst zones, first in one direction, then reversed, by-passing the combustion zone, and the hydrogen-rich reformed gas, is collected at the outlet of the appropriate

storage-catalyst zone during each half of the "make". Air may be injected on the make cycle, and enriching hydrocarbons may be added to the make gas, so that a wide range of interchangeability may be attained in a city gas to suit different areas. O. P. Brysch

Russian Coke Ovens

Far, W. THE COKE-OVEN INDUSTRY IN THE U.S.S.R. *Coke and Gas* (British), 17, 389-96 (1955) October.

A history of the development of the Russian coke-oven industry is given, with details listed for distinct periods: pre-1913; war and nationalization in 1913-18; reconstruction 1919-1929; reorganization and aid of foreign specialists 1929-1934; emancipation from foreign dependence 1934-1940; World war II and recent 1941-54. Brief tables give coke production, coal supply, coke quality and byproduct data. The extensive work of Russian engineers to develop their own raw materials, oven designs and technical staff is emphasized. Names of researchers and certain Russian literature sources are given.
O. P. Brysch

Steam & Power Supply

Wilkinson, B. SOME POWER PROBLEMS INVOLVED IN THE MANUFACTURE AND DISTRIBUTION OF GAS. *Gas Times* (British) 85, 31, 34, 36, 38, 40, 42 (1955) October 14; *Gas World,* (British) 142, 970-75 (1955) October 15.

The author deals with power problems relating to both manufacture and distribution in the Watford Division of the Eastern Gas Board. Methods of distributing gas to the new towns of Stevenage and Hemel Hempstead are discussed, and a section is included to give some information on the use and economics of diesel engines. In the final section the author reviews the preliminary investigations made into the power position on a medium size works where for many years a continuous increase of the electrical load had been taking place and steam had been used at boiler pressure for all purposes. With the prospect of further steam production from waste-heat, it became apparent that more steam was becoming available than could conveniently be used. Author's Abstract

Tar Properties

Mapstone, G. E. SPECIFIC GRAVITY-TEMPERATURE RELATIONSHIPS OF COAL TAR AND ITS DISTILLATE FRACTIONS. *J. Appl. Chem.* (British), 5, 582-88 (1955) October.

The specific gravity-temperature coefficients of a wide range of coal tars were correlated with the specific gravity (S.G.) by the formula

$$d(S.G.)/dt = 0.001778\text{-}0.000980(S.G.)$$

A similar relationship for coal tar distillates could not be derived, but it was found possible to correlate their coefficients with their mean (or 50%) boiling points as

$$d(S.G.)/dt = 0.001477 - 0.000322 \log (T - 60).$$

The data for pure hydrocarbons are in agreement with this empirical relationship.
Author's Abstract

Tar Recovery

Harris, F. W. (assigned to Wulff Process Co.) PROCESS FOR REMOVING UNDESIRED TARS FROM A CRACKED GAS. U. S. 2,721,888 (1955) October 25.

Undesired tars are removed from a stream of gas from a hydrocarbon pyrolysis process by,—(a, intimately contacting the gas, at a temperature substantially above the vaporizing point of water, with a liquid at a controlled lower temperature, (b, controlling the liquid temperature by injecting small amounts of water, and (c, maintaining the cooling liquid at constant volume by proper overflow of condensate. Kerosene may be used as the liquid, which is recirculated into a spray-manifold in the gas stream and drains downward to a constant-level sump. Excess tarry liquid may be recycled to the cracking furnace. O. P. Brysch

Pettyjohn, E. S. (assigned to The Institute of Gas Technology, Chicago) APPARATUS AND METHOD FOR RECOVERY OF DRY OIL GAS TAR. U. S. 2,719,819 (1955) October 4.

In a method for cracking petroleum oil with the formation of oil gas and tar, the tar is recovered in dry form by bubbling the gas-tar vapor mixture from the cracking unit through a wash box containing a sealing layer of dry tar maintained at 250°-300° F., so that tar is condensed here but gas and steam pass forward

to a condenser. The condensate formed in this condenser may be returned to the dry tar wash box or sprayed into the raw gas inlet at controlled rates to achieve gas cooling to a temperature above 212° F. by evaporation of the water or emulsion. The dry tar collects in the wash-box and overflows through a seal to a dry-tar receiver. O. P. Brysch

5. NATURAL GAS AND NATURAL GAS CONDENSATES

Carbon Black

Allan, D. L. THE PREVENTION OF ATMOSPHERIC POLLUTION IN THE CARBON BLACK INDUSTRY. *Chem. and Ind.*, No. 42, 1320-24 (1955) October 15.

The methods of carbon black separation used in the English carbon black production industry are described. D. V. Kniebes

Bray, R. I., and Dobbin, R. E. (assigned to Godfrey L. Cabot, Inc.) PROCESS OF MAKING HARD CARBON BLACK PELLETS. U. S. 2,719,779 (1955) October 4.

A method is described which produces hard carbon black pellets having a carbon purity of 99.5% or higher and is suitable for use in carbon electrodes and as a carbonizing agent in the production of steel.

D. V. Kniebes

Mayland, B. J. (assigned to Phillips Petroleum Co.) CARBON BLACK PRODUCTION. U. S. 2,716,053 (1955) August 23.

A process by which carbon black is produced from carbon monoxide by improved methods is described. D. V. Kniebes

Wood, J. Q. (assigned to Phillips Petroleum Co.) RECOVERY OF CARBON BLACK. U. S. 2,719,135 (1955) September 27.

A method is described for the recovery of carbon black from the production furnace effluents in which the carbon black is recovered with unvulcanized rubber as a rubber-carbon black mixture. D. V. Kniebes

Compression

Dotterweich, F. H. and Mooney, C. V. HOW TO DESIGN AND OPERATE GAS JET COMPRESSORS. *Petroleum Refiner*, 34, 104-09 (1955) October.

A discussion of jet compressor design including graphs for estimating natural gas requirements and a development of various equations useful to jet design. R. F. Bukacek

Koenig, C. F. and Holveck, L. J. TAILOR CENTRIFUGALS TO YOUR CONDITIONS. *Petroleum Refiner*, 34, 110-15 (1955) October.

A discussion of design consideration in selecting a centrifugal compressor for pipeline. Numerous graphs and design conditions are presented. R. F. Bukacek

Construction Techniques

HOW A PIPELINE SPREAD OPERATES. *Oil Gas J.*, 54, 146-50 (1955) October 10.

A description of the operations and equipment involved in laying a pipeline from start to finish. Illustrated. G. G. Wilson

Cost Estimating

Elam, J. B. PIPELINE COST ESTIMATING. *Oil Gas J.*, 54, 139-45 (1955) October 10.

An outline of the pipeline cost estimating handbook developed by the economics group of Interstate Oil Pipeline Co. Information presented includes a recommended procedure for developing any economic study and rule-of-thumb factors for estimating various types of costs.

G. G. Wilson

Dew Points

Kobayashi, R. and Katz, D. L. METASTABLE EQUILIBRIUM IN THE DEW POINT DETERMINATION OF NATURAL GASES IN THE HYDRATE REGION. TECHN. NOTE 294. *J. Petroleum Techn.*, 7, 51-2 (1955) August.

This paper presents an explanation for the observation that the dew point of natural gases in equilibrium with gas hydrates is lower than that obtained for natural gas in equilibrium with water. R. F. Bukacek

Exploration

Cortes, H. C. and Gsell, R. N. THERE'S OIL UNDER THOSE SHELVES. *Oil Gas J.*, **54**, 103-07 (1955) October 3.

This article describes various methods in locating off-shore oil formations. The procedures discussed include gravity exploration and seismic exploration by refraction and reflection methods. Contour maps, location of the various findings using all three methods, and a table of prospecting costs and places are given.

J. R. Hasenberg

Gray, G. R. WHY GEOLOGISTS SHOULD KNOW ABOUT MUD IN ROTARY DRILLING. *World Oil*, **141**, 156-60 (1955) October.

The petroleum geologist must be concerned, in rotary drilling, with the drilling fluid because it is the vehicle that brings to the surface information about the strata penetrated by the bit. The article explains how the information furnished by cuttings, cores, mud analysis, and electric logging are dependent on the drilling mud.

R. S. Walters

Morley, H. T. EXPLORATION MEN MUST WORK HARD AND WELL TO FIND NEEDED OIL. *World Oil*, **141**, 121-24, 127 (1955) October.

In 34 years (1919 to 1954) oil demand has multiplied 5 times, to the present 7 million bbls. per day. Conservative projection indicates that 11 million bbl per day will be needed in 1965. In the face of this future demand, it appears that oil geologists must greatly improve their oil-finding-methods, such as they did with the introduction of the seismograph in 1920. Then the problem was to evolve oil detection methods which would ensure discoveries in other areas than those of good surface outcrops of favorable structures,—in essence, to cheapen drilling. The same problem exists today, in exploring remaining and older areas at greater depths. Intensified research in geology,—on sedimentation by core studies, electric well logging and micro-paleontology, and in improved seismograph techniques,—as well as in gas, sonic or vibration drilling methods, will probably improve the rate of discovery. With nuclear energy not too competitive before 1980, oil and gas must continue to supply a major part of the national energy. Here a free competitive system should be just as successful as in the past.

O. P. Brysch

Smith, D. T. GEOPHYSICAL METHODS OF OIL PROSPECTING—A REVIEW. V.-WELL-LOGGING METHODS. *Petroleum* (British), **18**, 285-89 (1955) August.

A review of the methods of geology as applied to the stratigraphic and lithologic logging of wells. Included in this article are resistivity, self-potential, and radioactivity logging.

B. E. Eakin

Gas Turbine Maintenance

Arnold, J. C. WHAT EL PASO NATURAL LEARNED ABOUT GAS-TURBINE MAINTENANCE. *Oil Gas J.*, **54**, 86-88, 91 (1955) October 31.

A well-planned preventive-maintenance program on gas turbines is paying off. The gas turbine has more electrical control than a reciprocating mover, and heavy electrical maintenance is required. This article gives the details of how the 10 gas-turbine stations are maintained.

Author's Abstract

H_2S Removal

Feagan, R. A., Lawler, H. L., and Rahmes, M. H. OPERATING EXPERIENCE WITH AMINE UNITS FOR H_2S REMOVAL. *Petroleum Eng.*, **27**, C48-50 (1955) October.

Tentative conclusions regarding aqueous amine unit design and operation are summarized based on the variables which have been sufficiently explored.

C. E. Pierson

Pratt, D. C., and Rutherford, A. REMOVAL OF HYDROGEN SULPHIDE FROM EXHAUST AIR FROM A VISCOSE STAPLE FIBRE FACTORY. *Chem. and Ind.* (British), No. 41, 1281-86 (1955) October 8.

Laboratory, pilot plant, and full scale studies of the application of the Ferrox process to the removal of H_2S from air are reported.

D. M. Mason

Rippie, C. W. and Bishop, H. B. REMOVAL OF ACIDIC GASES FROM HYDROCARBON

GASES AND LIQUIDS. U. S. 2,722,500 (1955) November 1.

In the amine process for removing acid gases from liquid and gaseous petroleum products, loss of amine to the treated fluid due to solubility of the amine therein is reduced by addition of an acid to the amine. The acid must be one that ionizes in two steps: the first ionization constant must be such that hydrolysis of the amine salt to the free acid is negligible. Acids of the kind used give salts of the amines that are hydrophilic, stable in water, practically insoluble in the hydrocarbon to be treated, have high absorption capacity for H_2S and CO_2, and lose these volatile acidic substances quickly when the solutions are heated to regenerate them. Phosphoric and hydrofluoric acids have been found to be particularly suitable.

D. M. Mason

Liquefied Storage

Morrison, W. L. (assigned to Union Stock Yards and Transit Co.) STORAGE AND SHIPPING CONTAINER FOR COLD LIQUEFIED GAS. U. S. 2,707,377 (1955) May 3.

This patent pertains to a jacketed vessel for the storage and for shipping of liquefied gas at atmospheric pressure. The vaporization rate within the tank is controlled by the cold gas itself escaping through the jacket-space or through a coiled vent-pipe therein, with a loose friable insulating filling (balsa-wood) in this space. B. E. Eakin

Measurement

Askew, J., Jr., and Cable, L. G. A PRACTICAL APPROACH TO THE MEASUREMENT OF FULL WELL STREAM GAS. *Petroleum Eng.*, 27, B90-92, 95 (1955) October.

Suggestions for overcoming the numerous problems involved in metering wet gas streams.

R. F. Bukacek

Rufleth, W. E. HOW COMPLEX A TELEMETERING SYSTEM? *Gas*, 31, 114-16, 119-20 (1955) November.

The author outlines various factors involved in choosing a telemetering system. A variety of system conditions and possible solutions are discussed. R. F. Bukacek

Nitrogen Removal

Haynes, P. E. (assigned to Koppers Company, Inc.) SYSTEMS FOR SEPARTING NITROGEN FROM NATURAL GAS. U. S. 2,716,332 (1955) August 30.

This invention relates to an improved process for the removal of nitrogen from natural gas. The uncondensed nitrogen, separated from the liquefied methane, is expanded with performance of external work and the cooled nitrogen so obtained is used to cool the condenser and raw-gas precoolers. B. E. Eakin

Northwest Pipeline

Ebdon, J. F. THE SCENIC INCH. *Gas*, 31, 177-92, 195-206, 209, 212, 213, 216 (1955) October.

An extensive article in 3 parts describing various phases of the development of Pacific Northwest Pipeline. The many factors involved, from the characteristics of the market to be served, to the company's organization, pipeline design and construction are covered. R. F. Bukacek

Offshore Operations

Campbell, E. E. HOW A LINE WAS TAPPED UNDER 22 FEET OF WATER IN THE GULF. *Pipe Line Ind.*, 3, 40-45 (1955) November.

A solution was found to a problem which will certainly face pipeliners who operate in the open waters of the Gulf of Mexico. A successful hot-tap was made on a line 22 feet below the surface of the water. It was made in a hinged bell which closes around the line like a clam bucket on a dragline, and was not expensive. Author's Abstract

HERE'S HOW THAT PHILLIPS OFFSHORE RIG WAS ERECTED. *Oil Gas J.*, 54, 80-81 (1955) November 28.

A step-by-step picture story records the erection of a big self-contained platform 40 miles from shore and in water 85 ft. deep. Phillips Petroleum Co. is drilling from the man-made island in Block 184, Eugene Island area, off St. Mary Parish, Louisiana. Editor's Abstract

Pipeline Cleaning

Hughen, P. L. INTERNAL CLEANING OF OPERATING LINES CAN IMPROVE GAS

FLOW EFFICIENCIES. *Petroleum Eng.*, **27**, D55, 57-61 (1955) November.

The use of scrapers for a stream cleaning of pipeline interiors to maintain flow efficiency is described and two types of scraper traps are illustrated. Results obtained by use of internal cleaning of three different sections of pipeline are summarized. [See also *Gas Abs.* **11**, 218 (1955) Dec.] G. G. Wilson

Pipeline Flow

Chenoweth, J. M. and Martin, M. W. TURBULENT TWO-PHASE FLOW. *Petroleum Refiner*, **34**, 151-55 (1955) October: *Pipe Line Ind.*, **3**, 50-2, 56, 57 (1955) November.

A report of tests on 1½ and 3-in. pipe with two-phase flow in the turbulent region. Test results are compared with the Lockhart-Martinelli correction and a modification of that correlation is proposed based on the new data. Results of 264 experimental runs with turbulent flow stage are discussed.

R. F. Bukacek

Davidson, J. F., Farquharson, D. C., Picken, J. Q. , and Taylor, D. C. GAS MIXING IN LONG PIPELINES. *Chem. Eng. Sci.*, **4**, 201-05 (1955) October.

Results of experimental work to determine the longitudinal mixing characteristics of gases flowing in pipes is reported. Hydrogen was used as a tracer in the flow of refinery gases in a 3-inch pipe. The hydrogen appears to assume a Gaussian distribution, the effective diffusion coefficient being in agreement with that given by Taylor for liquids. R. F. Bukacek

Production Techniques

Abendroth, G. F. (assigned to Esso Research and Eng. Co.) FRACTURING FORMATIONS SELECTIVELY. U. S. 2,716,454 (1955) August 30.

This invention describes a method and apparatus for the selective fracturing of formations.

B. E. Eakin

Raimer, B. COST, PRICE AND DRILLING RATE REVEAL TRENDS. *Drilling*, **16**, 126-27 (1955) September.

The present price of drilling and the relative costs of labor and equipment are compared with the same costs in 1940. The trend indicates that on a footage basis the price of drilling in 1954 was almost identical with that in 1941. Graphs are presented. B. E. Eakin

Scott, J. O. NEW TOOL DRILLS WITH STEEL BALLS. *Oil Gas J.*, **54**, 84-86 (1955) October 3.

Carter Oil Company's new drilling tool, its operation, and development are described. The advantages of the new steel-ball jet drilling tool are cited as: reduction in drill pipe wear, lower drill-bit cost, reduced rig investment, and fewer round trips of pipe-string to change tool bits. Action of the steel balls in the drill string, formation cutting, power limitation, and drilling rates through various types of rocks for a given diameter are discussed. Effects of ratio of primary to secondary jet areas, and drilling fluid density on drilling rates are explained.

J. R. Hasenberg

Whitfield, M. A., Clark, R. C., Jr. NEW FRACTURING FLUID. *Petroleum Eng.*, **27**, B85, 86, 89, 90, 92, 93 (1955) September.

The development of additives which can be combined with lease crude have resulted in a fracturing fluid having very desirable viscosity and fluid loss characteristics. The result to date indicate about 95% success in obtaining production increases. B. E. Eakin

Pulsation

Newmann, C. and Moerke, N. H. CONTROLLING PULSATIONS IN GAS PIPING SYSTEMS. *Oil Gas J.*, **54**, 117-18 (1955) October 24.

A brief discussion of pulsation dampener types, their characteristics, advantages and disadvantages. R. F. Bukacek

Reservoir Behavior

Arps, J. J., Roberts, T. G. THE EFFECT OF THE RELATIVE PERMEABILITY RATIO, THE OIL GRAVITY, AND THE SOLUTION GAS-OIL RATIO ON THE PRIMARY RECOVERY FROM A DEPLETION TYPE RESERVOIR. T. P. 4103. *J. Petroleum Techn.*, **7**, T120-28 (1955) August.

The depletion equation has been solved for a large number of conditions, each parameter being varied over the normal range encountered

in reservoirs. The main parameters were rock type, API gravity, and solution gas. The rock type was identified by the relative permeability relationship. It was concluded that recovery of oil from a depletion type reservoir can be correlated with the solution gas-oil ratio, the API gravity, and the rock type.

B. E. Eakin

Cullender, M. H. THE ISOCHRONAL PERFORMANCE METHOD OF DETERMINING THE FLOW CHARACTERISTICS OF GAS WELLS. T. P. 4120. *J. Petroleum Tech.*, 7, T137-42 (1955) September.

An empirical method is presented for calculating the true slope (n) of the back-pressure curve for wells which fail to stabilize within a reasonable test period. The back-pressure performance of such a well would be represented by this method as a series of parallel curves, each curve representing the performance of the well at the end of a given time interval.

B. E. Eakin

Mueller, T. D., Warren, J. E., West, W. J. ANALYSIS OF RESERVOIR PERFORMANCE k_g/k_o CURVE MEASURED ON A CORE SAMPLE. *J. Petroleum Techn.*, 7, 128-31 (1955) August.

Two performance type k_g/k_o curves were calculated by use of a digital computer, at two different production rates from production performance of a hypothetical reservoir for which a laboratory type relative permeability curve was assumed. The performance type curve for the lowest production rate most nearly coincided with the laboratory curve. This verifies that the assumption of uniform pressure and saturation throughout the reservoir used in calculating performance k_g/k_o curves is the important reason for difference between the laboratory and field curves. B. E. Eakin

Pings, C. J., Jr., and Tempelaar-Lietz, W. CANAL FIELD GAS INJECTION PROJECT. *J. Petroleum Techn.*, 7, 25-31 (1955) August.

Data from published histories of the performance of the Canal field gas injection project were reviewed, and natural balance calculations made to determine the oil in place, the size of the oil reservoir, the relative volume of the aquifer, water inflow, and hydrocarbon migration within the reservoir. The gas-injection programs results are also discussed. Special emphasis was placed on examination of the recorded pressure measurements and the fluid P-V-T behavior. B. E. Eakin

Turbodrill

Postlewaite, W. R. WHAT'S HAPPENING TO TURBODRILL DEVELOPMENT? *World Oil*, 141, 156-60 (1955) October.

The author compares turbodrilling to conventional drilling and finds turbo-drilling to be very favorable. In this comparison the mechanism of turbodrilling is described in some detail. A portion of the history of turbodrilling, results of experimental drilling, together with a few of the problems connected with this drilling method are also discussed in this article.

R. S. Walters

Postelwaite, W. R. U. S. PROGRESS IN DRILLING WITH THE TURBODRILL. *Oil Gas J.*, 54, 93-97 (1955) November 7.

American designs are now available which make the use of the turbodrill competitive with rotary drilling. Further work is required in developing small-diameter turbines, widening the range of rotational speeds, testing of a rotary speed indicator, and developing improved bearings. Author's Abstract

Trebin, F. A. RUSSIAN TURBODRILL PROGRESS. *Oil Gas J.*, 54, 97-99 (1955) November 7.

This is a major drilling method in Russia. By delivering large amounts of power to the bit the turbodrill has achieved drilling rates up to 10 times those claimed to be obtainable by conventional drilling. Author's Abstract

Well Casing Strength

Peret, J. W. ECONOMIC SELECTION OF HIGH STRENGTH CASING. *Petroleum Eng.*, 27, (1955) October.

It is suggested that, for the bottom of the string, selection of casing efficient in collapse strength, for the top use of casing most efficient in tension strength, and for the string center use of most efficient burst resistance casing will result in economic savings since no tubular materials now available combine the required properties at reduced cost. R. F. Bukacek

6. PETROLEUM AND SYNTHETIC LIQUID FUELS

Bureau Mines Research

Cattell, R. A. and others. PETROLEUM AND NATURAL-GAS RESEARCH PROGRAM, BUREAU OF MINES FISCAL YEAR 1953. Bur. Mines Inf. Circ. 7717 (1955) June.

A review is given of current work at the Bureau on such topics as well productivity, secondary recovery, petroleum chemistry and sulfur compounds in petroleum.

R. T. Ellington

Desulfurization

Porter, F. W. (assigned to The British Petroleum Co.) CATALYTIC DESULFURIZATION OF PETROLEUM HYDROCARBONS. U. S. 2,719,108 (1955) September 27.

The process for catalytically desulfurizing petroleum hydrocarbons in the liquid phase without an external source of hydrogen is improved by carrying out the process in two stages. Hydrogen produced in both stages is fed to the second stage, allowing a lower space velocity or higher temperature to be used without deleterious effects which would otherwise occur.

D. M. Mason

Van Zijll Langhout, W. C., Stijntyes, G. J. F. and Waterman, H. I. DESULFURIZATION OF GAS OILS BY CATALYTIC HYDROGENATION. *J. Inst. Petroleum* (British), **41**, 263-72 (1955) August.

The significance of desulfurization in the petroleum industry is discussed, and a review is given of some important industrial hydrodesulfurization processes. Thermodynamic calculations of the possibility of desulfurization and dehydrogenation reactions in distinct simplified systems (mixtures of equimolecular amounts of methyl thiophene, methylcyclohexane and hydrogen) show, that in the equilibrium, at a certain temperature, a total pressure can be calculated at which no production or consumption of hydrogen occurs. This forms the base of the so-called "Autofining" process, in which mineral oils are desulfurized by hydrogenation, whilst the necessary hydrogen is obtained by dehydrogenation of the naphthenes in the feed.

A description is given of desulfurization experiments on Middle East gas oils in the gas phase, using a Co-Mo-Al_2O_3-catalyst.

Authors' Abstract

Winslow, W. H. and Weikart, J. HIGH SULFUR CRUDES NEED NEW PROCESSES. *Petroleum Refiner*, 34, 220-26 (1955) September.

In this hypothetical refinery, the fluid coking and hydrofining processes join hands to permit economical running of high-sulfur crude in a low-sulfur refinery. Authors' Abstract

Evaporation Losses

Walker, E. H., Eltringham, R. M., and Puttick, A. EVAPORATION LOSSES FROM PETROL STORAGE TANKS IN THE UNITED KINGDOM—A PRACTICAL SURVEY. *J. Inst. Petroleum*, **41**, 297-327 (1955) October.

This paper presents thermal breathing loss measurements obtained from both standing and working tanks located in a number of places in the U.K. A method is given by which the results can be correlated and used to predict thermal breathing losses from readily available data. The results emphasize the importance of maintaining the tank and its fittings in a vapour-tight condition. The mathematical basis of the survey is given, formulae used are derived, and their method of application explained.

Authors' Abstract

Fischer-Tropsch

Schlesinger, M. D., and Benson, H. E. UPGRADING FISCHER-TROPSCH PRODUCT. *Ind. Eng. Chem.*, **47**, 2104-08 (1955) October.

Liquid products from Fischer-Tropsch synthesis may be treated over activated alumina in the same manner as petroleum products. The primary reactions are dehydration of alcohols and shifting of olefin bonds. Other oxygenated compounds are converted to hydrocarbons with evolution of carbon oxides. Comparisons are given between treated and untreated products.

E. B. Shultz

Octane Improvement

Sittig, M. and Warren, W. HOW TO GET THOSE TOP OCTANES. *Petroleum Refiner*, **34**, 230-280 (1955) September.

This is a comprehensive monograph on octane

improvement techniques, including the most authoritative comparison of catalytic reforming to date. Special attention is given to the economics of producing those last few octane numbers now necessary for high compression engines. Considered also for their contribution to octane improvement are polymerization, alkylation, isomerization, process combinations and tetraethyl lead. References total 329.

D. J. Dennison

Petroleum Compounds

Ball, J. S., Bordwell, F. G., Smith, H. M., Waddington, G., and Seyfried, W. D. API RESEARCH PROJECT 48—SYNTHESIS, PROPERTIES, AND IDENTIFICATION OF SULFUR COMPOUNDS IN PETROLEUM. *Amer. Petroleum Inst. Proc., Section VI*, **34**, 106-47 (1954).

API Research Project 48 has made excellent progress in the past 2 years in obtaining data on compounds and in identifying individual and type sulfur compounds in a typical crude. Synthesis of thiols from olefins via thiolacetic acid, and of benzothiophenes has been developed. Ten high-purity, large-volume compounds and 35 additional smaller-volume compounds have been prepared to total 91 on which properties and data are available. Thermodynamic data are now available on propyl and butyl sulfide and thiol isomers. Since 1952 twenty-seven sulfur compounds have been identified in Wasson crude oil to a total of 43. Adsorption, complexing and thermal diffusion have been applied in separating the compounds in fractions up to 220° C.

Authors' Abstract

Rossini, F. D. and Shaffer, S. S. API RESEARCH PROJECT 6 — ANALYSIS, PURIFICATION, AND PROPERTIES OF PETROLEUM HYDROCARBONS FRACTIONATING PROCESSES. *Amer. Petrol. Inst. Proc., Section VI*, 34, 14-61 (1954).

This report describes the work of the API Research Project 6 on fractionating processes for hydrocarbons from petroleum, under the following headings: principles of fractionation and fractionating processes, regular distillation, azeotropic distillation, regular distillation at different pressures, distillation at very low pressures, extraction, adsorption, crystallization, and solid molecular compounds. Also included is a list of the 141 hydrocarbons isolated from the project's representative petroleum and a list of the 228 API Research hydrocarbons purified—both lists as of June 30, 1954.

Authors' Abstract

7. ANALYTICAL METHODS AND TESTS

Carbon in Air

Glayton, G. D., Arnold, J. R., Patty, F. A. DETERMINATION OF SOURCES OF PARTICULATE ATMOSPHERIC CARBON. *Science*, 122, 751-53 (1955) October 21.

A method of measuring the particulate carbon content of the atmosphere is described. It utilizes radioactivity measurements of samples collected by filtration. D. V. Kniebes

CO Infrared Spectra

Plyler, E. K., Blaine, L. R., and Tidwell, E. D. INFRARED ABSORPTION AND EMISSION SPECTRA OF CARBON MONOXIDE IN THE REGION FROM 4 TO 6 MICRONS. *J. Res. Nat. Bur. Standards*, 55, 183-89 (1955) October.

Carbon monoxide and carbon dioxide have been measured with high resolution in the region from 4 to 6 microns. The complete emission spectra of carbon monoxide and carbon dioxide in this region are shown. E. Mann

Germanium Method

Almond, H., Crowe, H. E., and Thompson, C. E. RAPID DETERMINATION OF GERMANIUM IN COAL, SOIL AND ROCK. Geol. Survey Bull. 1036-B, U. S. Dept. of Interior (1955). Introduces a speedy modification of Cluley's colorimetric method for the determination of germanium in coal with phenylfluorone and adaptation of the method to soils and rocks. Sensitivity of 2 ppm germanium in coal and 1 ppm in soil or rock is obtainable. A. J. Tulis

Iron Carbonyl

Sendroy, J., Jr., Collison, H. A., and Mark, H. J. DETERMINATION OF IRON PENTACARBONYL IN COMMERCIAL CARBON MONOXIDE. *Anal. Chem.*, 27, 1641-45 (1955) October.

In the course of experimental work in which

carbon monoxide from steel containers was used, the presence in the gas of a substance which appeared on qualitative test to be iron pentacarbonyl, $Fe(CO)_5$, was noted. Further investigation led to the development of a specific, rapid, and accurate method for its determination, with particular application to its presence as an impurity in commercial carbon monoxide. The gas sample to be analyzed, in volume up to 10 liters, is passed through traps in which the pentacarbonyl is condensed or absorbed, then measured spectrophotometrically at 235 millimicrons in methanol solution. An average accuracy within 1.3 is obtained in analyses of samples holding a minimum of 0.04 mg. of iron pentacarbonyl. The concentrations present in commercial carbon monoxide in steel cylinders have been found to range from 0.16 to 18 mg. per liter. Authors' Abstract

Nitrogen Oxides

Norris, M. S., Fleck, S. A., and Lichtenfels, D. H. ULTRAVIOLET ABSORPTION DETERMINATION OF NITROGEN DIOXIDE. *Anal. Chem.*, 27, 1565-68 (1955) October.

The determination of nitrogen dioxide in a mixture containing all the oxides of nitrogen is difficult because of the high reactivity of nitrogen dioxide and nitrogen tetroxide. A description is given of the experimental and calculation details necessary for the determination of nitrogen dioxide and nitrogen tetroxide by ultraviolet absorption at 394 millimicrons, where the other oxides of nitrogen are transparent. E. Mann

Odor Tests

A.S.T.M. SYMPOSIUM ON ODOR. ASTM Spec. Techn. Publn. No. 164; 81 pp. ASTM, Philadelphia, Pa. (1954).

A symposium by ASTM Committee D-22 on Atmospheric Sampling and Analysis at the annual meeting of the A.S.T.M. June 15, 1954 presented the following papers: Sagarin E. pp. 3-8, in which several basic definitions terms, concepts, and mechanisms encountered in the odor field are proposed; Ruff, R. J. "Catalytic Method of Measuring Hydrocarbon Concentrations in Industrial Exhaust Fumes." pp. 9-22, giving a discussion of test equipment based on catalytic combustion for the analysis of industrial exhaust fumes for hydrocarbons; Deininger, N. and McKinley, R. W. "The Design, Construction, and Use of An Odor Test Room." pp. 23-32, with a description of the odor test room developed by the Arthur D. Little Co. in connection with their work on odor for the American Gas Association; Gee, A. H. "Organoleptic Appraisal of Three-Component Mixtures." pp. 33-55, giving the results of a study of methods of controlling undesirable odors in hospital aircraft, which involved the introduction of three kinds of odorants in various proportions into a special dynamic flow system and appraisal of the resulting odor mixture by smelling it, with the results presented in tabular and graphical form; Gruber, C. W. "Odor Pollution from an Official's Viewpoint." pp. 56-68, discussed the outdoor odor pollution problems in Cincinnati and the use of the "sniff" method of odor monitoring by trained observers; Turk, A. "Odor Control Methods: A Critical Review." pp. 69-81, presented a critical evaluation of the four basic methods of reducing air pollution that are now commercially available: 1) combustion; 2) adsorption; 3) absorption; 4) vapor mixing, with illustration of typical commercial equipment. The discussions that attended the presentation of each paper at the symposium are also presented. G. G. Wilson

Organic Oxygen Method

Lee, T. S. and Meyer, R. A NEW METHOD FOR THE DETERMINATION OF OXYGEN IN ORGANIC COMPOUNDS. *Anal. Chim. Acta*, 13, 340-49 (1955) October.

Oxygen in compounds of carbon, hydrogen, and oxygen can be determined by heating the sample with an excess of strontium oxide and graphite in a nickel bomb or sealed Vycor glass tube. During the heating period, three hours at 650° C. the oxygen of the sample is converted to carbonate. The carbonate is then determined volumetrically. The accuracy of the method was found to be $\pm 0.3\%$ (absolute percentage error) for several types of compounds. Most elements other than carbon, hydrogen, and oxygen interfere. Compounds like phenol, that are exceedingly resistant to complete pyrolysis, yield low results. Carbon in organic compounds can be determined by heating the sample with barium nitrate, and subsequently determining carbonate in the mixture. Authors' Abstract

Spectrophotometry

Lothe, J. J. INDIRECT SPECTROPHOTOMETRY — A STUDY OF PRECISION. *Anal. Chem.*, 27, 1546-51 (1955) October.

The theory of the precision of indirect spectrophotometry, which is concerned with the measurement of the decolorization of a colored system, is presented and discussed. Methods of obtaining the highest precision possible by this method are presented. R. R. Amrine

Sulfate Determination

Davey, W. and Gwilt, J. R. ANALYTICAL APPLICATIONS OF SODIUM LAURYL SULPHATE. II.—THE VOLUMETRIC DETERMINATION OF SULPHATES. *J. Appl. Chem.* (British), 5, 474-76 (1955) September.

The literature on the ethylenediaminetetraacetate method for determination of sulphate is reviewed and the limitations of the method are discussed. In the procedure now described, after precipitation of sulphate as barium sulphate, excess barium is precipitated with sodium lauryl sulphate and excess of the latter titrated with a suitable quaternary ammonium salt as described in Part I of this series.

Authors' Abstract

Sulfite Method

Rao, K. B. and Rao, G. G. OXIDIMETRIC METHODS FOR THE VOLUMETRIC ESTIMATION OF SULPHITE. *Anal. Chim. Acta*, 13, 313-322 (1955) October.

The use of permanganate, ceric sulphate, and dichromate for the estimation of sulphite has been reinvestigated, although these reagents have been discarded as useless by earlier investigators. By using catalysts under controlled acid concentration, we have been able to develop conditions for the quantitative oxidation of sulphite to sulphate at room temperature by any of these oxidizing agents, avoiding the formation of dithionate. Copper sulphate and iodine monochloride have been found useful as catalysts with potassium permanganate and dichromate; but only iodine monochloride with ceric sulphate. Sodium sulphite is also oxidized quantitatively to sulphate at room temperature, when added to excess of sodium vanadate solution containing 5 to 6N hydrochloric acid and iodine monochloride as catalyst.

Authors' Abstract

8. GENERAL AND PHYSICAL CHEMISTRY

Compressibility

Hall, N. A. and Ibele, W. E. COMPRESSIBILITY DEVIATIONS FOR POLAR GASES. *Amer. Soc. Mech. Eng. Trans.*, 77, 1003-09 (1955) October.

Charts are presented which permit the calculation of compressibility factors for polar gases by applying a polarity correction term to the compressibility read from standard charts. Employing an "extended law of corresponding states" the polarity correction is shown to be dependent on the molecular dipole moment of the particular polar gas. B. E. Eakin

Hydrocarbon Viscosity

Grunberg, L. THE VISCOSITY OF LIQUID HYDROCARBONS. *J. Inst. of Petroleum*, 41, 249-62 (1955) August.

The prediction of the viscosity versus temperature behavior of liquid hydrocarbons has received considerable study. The equations derived from theoretical considerations have not represented natural systems. The author presents his theory as to the cause for this discrepancy, and an approach and method for obtaining accurate viscosity behavior predictions. B. E. Eakin

Phenol Solubility

Terres, E., Gebert, F., Hülsemann, H., Petereit, H., Toepsch, H., and Ruppert, W. ZUR KENNTNIS DER PHYSIKALISCH-CHEMISCHEN GRUNDLAGEN DER GEWINNUNG UND ZERLEGUNG DER PHENOLFRAKTIONEN VON STEINKOHLENTEER UND BRAUNKOHLENSCHWELTEER. VI. MITTEILUNG UNTERSUCHUNGEN UEBER DIE BINAEREN LOESUNGS-SYSTEME VON WASSER MIT PHENOL UND EINWERTIGEN PHENOLEN UND DEREN KRITISCHE LOES UNGSTEMPERATUREN. (INFORMATION ON THE PHYSICAL-CHEMICAL BASIS OF THE RECOVERY AND SEPARATION OF THE PHENOL FRACTIONS OF COAL TAR AND BROWN COAL LOW-TEMPERATURE TAR. PART VI. INVESTIGATIONS OF THE BINARY SOLUTION SYSTEMS OF WATER WITH PHENOL AND UNIVALENT PHE-

NOLS AND THEIR CRITICAL SOLUTION TEMPERATURES.) *Brennstoff-Chemie* (German), 36, 289-301 (1955) October 12.

Data are reported for phenol and 32 other univalent phenols on their binary solution systems, with the critical solution temperatures and the corresponding phase compositions. Comparisons, in tabular and graphical form, indicate certain rules of conformity. Critical solution temperature increases with the number and size of the substituent, however the arrangement of these substituents on the ring and their distance from the hydroxyl group has great significance, as in general it is higher, the closer the substituents are to the hydroxyl. Properties of homologs up to pentamethyl phenol, and of mixtures of phenol with various homologs, as well as methods of analysis, are discussed in detail. O. P. Brysch

Oxygen Solubility

Gameson, A. L. and Robertson, K. G. THE SOLUBILITY OF OXYGEN IN PURE WATER AND SEA-WATER. *J. Appl. Chem.* (British), 5, 502 (1955) September.

A simple equation expressing solubility of oxygen in saline water is given.

D. M. Mason

Thermal Conductivity

Kowalczyk, L. S. THERMAL CONDUCTIVITY AND ITS VARIABILITY WITH TEMPERATURE AND PRESSURE. *Amer. Soc. Mech. Engs. Trans.*, 77, 1021-35 (1955) October.

This paper gives a summary of the present status of the theory of thermal conductivity and attempts to explain its variability with temperature and pressure by means of the nature of heat, structure of matter, and resistances offered by matter to heat conduction at various physical states. Experimental data are used to illustrate theoretical considerations; long mathematical derivations are thoroughly avoided.

Author's Abstract

9. ORGANIC CHEMISTRY

Acetylene Production

Harris, F. W. (assigned to Wulff Process Co.) PROCESS FOR PRODUCING ACETYLENE. U. S. 2,718,534 (1955) September 20.

An invention of a process for producing a valuable acetylene gas from a suitable hydrocarbon wherein: a substantial portion of the recoverable heat is extracted from the off-gas, stored and transferred to the in-gas by means of a regenerative mass; all or part of the reaction heat is supplied by combustion of in-gas during formation of off-gas; the reaction and all other heat of process is supplied by combustion gas, preferably the waste gas from the process.

A. J. Tulis

Synthetic Ammonia

Vivian, C. H. SYNTHETIC AMMONIA GIANT. *Compressed Air*, 60, 288-96 (1955) October.

Descriptions are given of the three main basic processes utilized in Grace Chemical Company's new $20-million synthetic ammonia plant in Tennessee. Of extraordinary interest are the large, high pressure compressors totaling over 20,000 hp. D. J. Dennison

10. CHEMICAL ENGINEERING

Drying

McEwen, E. and O'Callaghan, J. R. THE EFFECT OF AIR HUMIDITY ON THROUGH DRYING OF WHEATGRAIN. *Instn. Chem. Engrs. Trans.*, (British), 33, No. 2, 135-54 (1955).

The effect of large variations in the air humidity on the drying of wheatgrain has been studied and it is found that with a suitable modification to cater for the relative air humidity, the method of McEwen, Simmonds, and Ward is still valid. Authors' Abstract

Russell, R. J. DRYERS AND DRYING COSTS. *Chem. Eng. Costs Quarterly*, 5, 96-104 (1955) October.

A brief discussion of drying equipment and relative costs. Power requirement, labor and maintenance costs are estimated for a number of standard operations. W. G. Bair

Fluid Flow

Li, Y. T. and Lee, S. Y. SURVEY OF MASS-RATE FLOW-MEASURING PRINCIPLES. Amer. Soc. Mech. Eng. Paper No. 55-SA-72 (1955) June 19-23.

In this paper, various mass-rate flow-measuring meters are classified according to their oper-

ating principles. The respective merits of the operating principles are discussed as well as their accuracy and suitability for differing flow conditions. Of particular interest are the recently developed transverse momentum meters that perform with high accuracy under a wide range of operating conditions. Three different designs utilizing this principle are described.
Authors' Abstract

Fractionation

Acrivos, A. and Amundson, N. R. ON THE STEADY STATE FRACTIONATION OF MULTICOMPONENT AND COMPLEX MIXTURES IN AN IDEAL CASCADE. PART V. THE EXTENSION TO PACKED COLUMNS. *Chem. Eng. Sci.*, **4**, 206-08 (1955) October.
Results derived in previous articles by the authors for the steady state fractionation of multicomponent and complex mixtures in an ideal cascade were extended to the case of packed columns, whereby the number of transfer units required for a specified degree of separation can be easily computed from readily calculable quantities. [See also *Gas Abs*, **11**, 206, (1955) Nov.]
S. Hu

Winn, F. W. DEVELOPMENTS IN FRACTIONATOR DESIGN. *Petroleum Eng.*, 27, C10-13 (1955) September.
This article is an annotated bibliography on recent advances in fractionator design. Covered are proprietary devices, column performance, and design methods.
B. E. Eakin

Heat Transfer

Chao, B. T. ON A GENERALIZED PROCEDURE FOR THE CALCULATION OF THERMAL RADIATION TRANSFER. Amer. Soc. Mech. Eng. Paper No. 55—SA-61 Boston (1955) June 19-23.
A systematic procedure is introduced for determining the radiant heat transfer between a radiating gas or flame and a gray receiving surface in a closed chamber consisting of n gray surfaces, all of different emissivities. The effect of radiating beam length on the absorptivity of the gas or flame is considered. The resulting equations are then modified for the calculation of radiant heat transfer between gray surfaces in an enclosure separated by non-absorbing media. The solution and particularly the method presented have wider application than those heretofore published. For numerical calculation, the results can be obtained readily from the digital computer.
Author's Abstract

Pipes, L. A. MATRIX ANALYSIS OF HEAT TRANSFER PROBLEMS. Amer. Soc. Mech. Eng. Paper No. 55-SA-34 Boston (1955) June 19-23.
This paper presents a method of analysis of heat conduction problems in solids based on matrix algebra. Use is made of the analogy that exists between the thermal problem and the flow of electricity in an electrical transmission line. It is shown that the use of matrix algebra greatly facilitates the calculation of transient and periodic heat flow in composite solids.
Author's Abstract

Pressure Safety

Weber, C. G. HOW TO PROTECT YOUR PRESSURE VESSELS. *Chem. Eng.*, **62**, 170-74 (1955) October.
The factors to consider in selection of safety devices for protection of pressure vessels is discussed. General misconceptions regarding the application of safety valves are pointed out and the proper method of evaluating valve requirements is given.
J. M. Reid

11. PROCESS EQUIPMENT AND INSTRUMENTATION

Gasoline Plant Control

Willard, B. J. INSTRUMENTATION OF A GASOLINE PLANT. *Instrumtn. and Autom.*, 28, 1536-39 (1955) September.
Important factors in the instrumentation of a natural-gasoline plant include 1) control of compressors, 2) temperature control system, 3) liquid-level control, 4) pressure and flow control, and 5) emergency safety instrumentation. The process, instrumentation, and operational factors are discussed.
Author's Abstract

Grinding Equipment

Stern, A. L. SIZE REDUCTION EQUIPMENT. PART I. *Chem. Eng. Costs Quarterly*, **5**, 105-09 (1955) October.
Part I of a two-part article on size reduction equipment considers type of equipment, selection of equipment and related factors.
W. G. Bair

Tubular Heaters

Mekler, L. A. PROCESS DESIGN OF TUBULAR HEATERS. *Oil Gas J.*, 54, 108-12, 115 (1955) October 3.

The author has treated the design of tubular heaters from the process standpoint rather than as simple heat transfer equipment which is of primary importance in petroleum operations. Where thermal cracking or other thermal reactions can occur or are desired within the heater coils the time-temperature effect is usually the controlling design factor. This effect however must be balanced against the physical characteristics of the heater and the normal heat transfer considerations. J. M. Reid

12. MATERIALS OF CONSTRUCTION

Cathodic Protection

Barnato, V. A. BEST INTERVALS FOR CATHODIC-PROTECTION UNITS. *Oil Gas J.*, 54, 238-40 (1955) October 10.

A description of a general method of designing multiple cathodic protection rectifier stations for pipelines. G. G. Wilson

Corrosion

Schwerdtfeger, W. J. and Denison, I. A. GEOMETRIC FACTORS IN ELECTRICAL MEASUREMENTS RELATING TO CORROSION AND ITS PREVENTION. *Corrosion*, 11, t423-32, (1955) October.

The "electrical boundary" of a galvanic couple immersed in an aqueous medium, when corroding normally and also when corrosion is stopped by cathodic protection, is discussed in the light of present theory. Experimental data, consisting of potential measurements made on bimetallic couples in an unrestricted medium producing relatively little polarization and also one producing considerable polarization, are compared with theoretical data. The electrical boundary is theoretically defined and experimentally verified for model galvanic couples having bimetallic electrodes, one couple simulating line electrodes and the others having electrodes made of longitudinal cylindrical segments arranged in three anode-to-cathode area ratios. The effect on potential measurements as a result of interference to the normal flow of galvanic and external currents is also shown by experimental data. The results of this study indicate that geometric factors should be given consideration in making potential measurements on subsurface structures of similar configuration, such as cylindrical tanks and pipelines. Authors' Abstract

Painting

Radecke, F. BASIC ESSENTIALS FOR THE REDUCTION OF ATMOSPHERIC CORROSION. *Corrosion*, 11, t437-41 (1955) October.

The factors to be considered in setting up a maintenance painting program are discussed. The factors of primary concern to paint engineers are noted as: 1) selection of paint; 2) surface preparation; 3) dry film thickness; 4) number of coats to be applied. The form of a typical paint specification is illustrated with a typical plant specification standard prepared by an oil company. G. G. Wilson

Rubber Gaskets

Austrian Assoc. Gas and Water Industries. EXPERIENCE IN THE FIELD OF UTILIZATION OF RUBBER JOINTS FOR GAS PIPELINES. International Gas Union, Paper IGU/3-55 6th Conference, New York, September 26-30 (1955).

A discussion of the results of a questionnaire submitted to members of the International Gas Union on experience with the use of rubber rings to obtain gas-tight pipe joints.

G. G. Wilson

Weld Testing

Tychon, N. H. M. ULTRASONIC TESTING OF WELDED JOINTS IN HIGH PRESSURE GAS PIPE LINES. International Gas Union Paper IGU/27-55 6th Conference New York, (1955) September 26-30.

A report on the techniques developed by the Netherlands State Mines for the testing of circumferential welded joints in steel pipe by means of ultrasonic vibrations. The article includes discussion of the principles of ultrasonic examination, apparatus, method of examination, and sample results comparing specimen cross sections, gamma ray photos and photographs of the corresponding oscilloscope indications from ultrasonic testing. Experience on a 14-inch line suggests that ultrasonic testing results may be obtained in about 20 minutes at a cost roughly $\frac{1}{15}$th that of X-ray examination for this pipe size. R. F. Bukacek

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